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Effect of *Tinospora cordifolia* Aqueous Extract on Traditional Food Crops of Garhwal Himalaya

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Abstract: The present study was conducted to estimate the allelopathic effects of *Tinospora cordifolia* on food crops. The result reveals that higher concentration of leaf and old shoot extracts inhibited the germination of *Sesamum orientala* and *Eleusine coacana* while higher concentration stimulate the germination of *Cajanus cajan*. The lower concentration of new shoots stimulates germination as compared to higher concentration. The higher concentration of leaf, new shoot and old shoot had suppressed radicle and plumule growth of all tested food crops as compared to lower concentration.

Key words: *Tinospora cordifolia* % Allelopathic effect % Food crops % Germination % Radicle and plumule growth

INTRODUCTION

In agriculture, simple crop rotation and cropping of some medicinal herbs may reduce the crop yield due to autotoxity [1]. Autotoxity can occur in crops growing in continuous monoculture, causing the stunted growth of plants and severe disease out breaks [2,3]. Allelopathy is defined as any direct or indirect effect (stimulation or inhibition) of one plants, including micro-organism on another plant through production and release of chemical compounds in the environment. It is well known that all higher plants release some phytotoxins into soil, which adversely affect the germination and final yield of associated plants. There may be several other competitions between the plants species for light, soil moisture, nutrients etc. Therefore, growth resources and bio-chemical influences are equally responsible for poor germination and further understorey growth of plants.

The allelopathic influences are due to allelochemicals, these allelochemicals present in all plant tissues includes leaves, flowers, fruits, stems, roots, rhizomes, seeds and pollen and there release from the plant in the environment from major ecological process i.e., volatilization, leaching, root exudation and decomposition of plant resides.

Guduchi [*Tinospora cordifolia* (Willd.) Miers ex Hook. F. and Thoms] is a large, glabrous, deciduous climbing shrub belonging to the family Menispermaceae [4,5]. It is distributed throughout tropical Indian subcontinent and China, ascending to an altitude of 300 m. In Hindi, the plant is commonly known as Giloya, which is a Hindu mythological term that refers to the heavenly elixir that have saved celestial beings from old age and kept them eternally young. The stems of *Tinospora cordifolia* are rather succulent with long filiform fleshy aerial roots from the branches. The bark is creamy white to grey, deeply left spirally, the space in between being spotted with large rosette like lenticels. The leaves are membranous and cordate. Guduchi is widely used in veterinary folk medicine/ ayurvedic system of medicine for its general tonic, antiperiodic, anti-spasmodic, anti-inflammatory, antiarthritic, anti-allergic and anti-diabetic properties [6,7]. The plant is used in ayurvedic, "Rasayanas" to improve the immune system and the body resistance against infections. The root of this plant is known for its antistress, anti-leprotic and anti-malarial activities [7,8]. The stem of *Tinospora cordifolia* is one of the constituents of several ayurvedic preparations used in general debility, dyspepsia, fever and urinary diseases. The stem is bitter, stomachic, diuretic [9], stimulates bile secretion, causes constipation, allays thirst, burning sensation, vomiting, enriches the blood and cures jaundice. Dry barks of *T. cordifolia* has anti-spasmodic, antipyretic [10], anti-allergic [11] and anti-inflammatory [12] properties. *T. cordifolia* is widely used in Indian ayurvedic medicine for treating diabetes mellitus [13].

The Indian system of medicine has already identified 1,500 medicinal plants of which 500 species are mostly used in the preparation of drugs. At present the

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international market for medicinal plant is valued at 60 billion per year, which is growing at the rate of 7% [14]. Generally the growth of some medicinally plants are in wild including *T. cordifolia*, where proper care or maintenance of these plants would be difficult and the plants are shrinking day by day. India at present exports herbal material and medicines of around Rs. 446 crores only which can be raised substantially, if suitable cultivation techniques of these plants can be followed with agricultural crops by farmers. To our knowledge, there is scarcity of information on the phytotoxic effects of *Tinospora cordifolia* on succeeding agricultural crops. The attention is being needed to the importance of rotation in medicinal plant or between medicinal herbs and other crops, due to strong allelopathic effects of medicinal plants [14,15,16]. Keeping in view the medicinal importance of *T. cordifolia* and to grow with crop combination for its sustain use, the following experiment was conducted to understand the effect of aqueous extract of different components of *Tinospora cordifolia* on germination, plumule and radicle growth of some traditional food crops.

MATERIALS AND METHODS

The present experiment was conducted in the experimental laboratory, Department of Forestry, HNB Garhwal University, Srinagar Garhwal (30°-13°N latitude, 78°-48°E longitude at altitude 550 m asl) Uttarakhand, India in the sub-tropical region of Garhwal Himalaya.

In bioassay culture, mature leaf, new shoot and old shoot of *Tinospora cordifolia* were collected. All collected components were sun dried and ground separately in a mechanical grinder. A powder sample of 1g, 3g, 5g and 7g of each component (leaf, new shoot and old shoot) were weighed and added to 100 ml of double distilled water to make percent solution for each sample and kept for 24 hours at room temperature (25±2°C). The resulting brownish and dark solutions were filtered through three layers of Whatman No. 1 filter paper and stored in a dark place in conical flasks until required. The effects of aqueous extracts on germination and radicle length were tested by placing 20 seeds of each test crop (*Sesamum orientale* L., *Cajanus cajan* (L.) Huth and *Eleusine coracana* L. Gaertner) in Petri dishes (four replicates) containing three layers of filter paper saturated with the aqueous extracts. A separate control series was set up using distilled water. Moisture in the Petri dishes was maintained by adding aqueous extracts or distilled water as required. The number of seeds germinated was counted everyday for seven days.

RESULTS

Germination: The germination of *S. orientale* was tested with three different aqueous solutions of *Tinospora cordifolia* leaf, new shoot and old shoot. The germination of *S. orientale* depressed in all aqueous extract over control. Among the sources of extracts new shoot was the most toxic to *S. orientale* followed by leaf and old shoot. The toxicity of new shoot indicated 100% inhibition of germination in 7% concentration.

Cajanus cajan was also observed for germination under same concentrations and source of leachates. The germination of *C. cajan* reduced in lower concentration (1%, 3% and 5%), however the higher concentration (7%) stimulated its germination. The old shoot in initial concentration (1%) suppressed germination which stimulated with increasing concentration of aqueous extract. New shoot had shown negative effect on germination with increasing concentration of aqueous extract. However, the old shoot has positive relation with increasing concentration.

The germination of *E. caracan* was suppressed in the all sources of aqueous extracts. Among the sources of extracts, in initial stage the maximum germination was in old shoot and with increasing concentration the germination was highly suppressed by new shoot followed by leaf and old shoot (Table 1).

Radicle and Plumule Length: The radicle and plumule growth of *S. orientale* in *T. cordifolia* in different concentration of solution is shown in Table 2. The 5% and 7% concentration of leaf aqueous extract was too toxic which inhibited complete emergence of radicle and plumule. The highest concentration (7%) of new shoot has also suppressed (100%) radicle and plumule growth whereas, minimum growth of radicle (0.53 cm) and plumule (1.30 cm) was in 5 % concentration. Similarly the growth of radicle and plumule in old shoot reduced with increasing concentration and maximum radicle and plumule growth was suppressed 96.66 and 68.69% respectively under 7% concentration (Table 2).

The radicle and plumule growth of *C. cajan* was also tested under same concentrations and treatments of *Tinospora cordifolia* which reduced radicle and plumule growth with increasing concentration of leaf and old shoot except new shoot which suppressed radicle and plumule growth completely (100%) in 7% concentration. *E. coacana* was also tested and found that radicle and plumule growth reduced with increasing concentration (Table 2).

Table 1: Effects of *Tinospora cordifolia* plant parts extract on germination of test crops

	Extract level (%)				
Treatment Extract[1]	0	1	3	5	7
Test crop = *Sesamum orientale* [2] (% germ) [3]					
Leaf	98.0	85.0 (-13.30)	77.0 (-21.43)	67.0 (-31.63)	22.0 (-77.55)
New shoot	98.0	92.0 (-6.12)	90.0 (-8.16)	12.0 (-87.76)	0.0 (-100.0)
Old shoot	98.0	97.0 (-1.02)	95.0 (-3.06)	88.0 (-10.20)	82.0 (-16.33)
Test crop = *Cajanus cajan* (% germ)					
Leaf	83.0	70.0 (-15.66)	70.0 (-15.66)	78.0 (-6.02)	85.0 (+2.41)
New shoot	83.0	92.0 (+10.84)	87.0 (+4.82)	83.0 (-0.00)	73.0 (-12.05)
Old shoot	83.0	77.0 (-7.23)	90.0 (+8.43)	92.0 (+10.84)	93.0 (+12.05)
Test crop = *Eleusine coracana* (% germ)					
Leaf	100.0	72.0 (-28.0)	70.0 (-30.0)	25.0 (-75.0)	20.0 (-80.0)
New shoot	100.0	77.0 (-23.0)	70.0 (-30.0)	30.0 (-70.0)	14.0 (-86.0)
Old shoot	100.0	85.0 (-15.0)	77.0 (-23.0)	68.0 (-32.0)	60.0 (-40.0)

[1]Treatment extract isolated from leaf or shoot of *T. cordifoli*

[2]Test crops are the plant seeds on which the extract was tested

[3]% Germ = percent seed germination for each test crop; values in parenthesis indicate percent stimulation (+) or reduction (-) as compared with controls not treated with extract. Means for a seed germination of test crop within a row having the same letter indicate no significant statistical difference between treatments at $p < 0.05$

Table 2: Effect of *Tinospora cordofolia* plant parts extracts on radicle and plumule growth

		Extract level (%)				
Treatment Extract[1]		0	1	3	5	7
	Test measure	Test crop = *Sesamum orientale* [2] (cm)[3]				
Leaf	Radicle	5.09	3.17 (-37.72)	1.61 (-68.37)	0.00 (-100)	0.00(-100.0)
	Plumule	4.95	4.99 (+0.81)	3.05 (-38.38)	0.00 (-100)	0.00 (-100.0)
New shoot	Radicle	5.09	2.99(-41.26)	1.35 (-73.48)	0.53 (-89.59)	0.00 (-100.0
	Plumule	4.95	5.66 (+14.34)	4.16 (-15.96)	1.30 (-73.00)	0.00 (-100.0)
Old shoot	Radicle	5.09	4.92 (-3.34)	1.43 (-71.91)	0.31 (-93.74)	0.17 (-96.66)
	Plumule	4.95	6.16 (+24.44)	3.51 (-29.09)	2.09 (-41.41)	1.55 (-68.69)
		Test crop = *Cajanus cajan* (cm)				
Leaf	Radicle	7.53	5.34 (-29.08)	2.13 (-71.71)	2.11 (-71.98)	0.92 (-87.78)
	Plumule	7.90	6.83 (-13.54)	5.80 (-26.58)	5.64 (-28.61)	2.91 (-63.16)
New shoot	Radicle	7.53	3.66 (-51.39)	1.35 (-73.48)	0.53 (-89.59)	0.00 (-100.0)
	Plumule	7.90	6.25 (-20.89)	4.16 (-15.96)	1.30 (-73.00)	0.00 (-100.0)
Old shoot	Radicle	7.53	5.35 (-28.95)	5.20 (-30.94)	3.53 (-53.12)	1.71 (-77.29)
	Plumule	7.90	5.23 (+33.80)	5.15 (-34.81)	6.18 (-21.77)	5.07 (-32.67)
		Test crop = *Eleusine coracana* (cm)				
Leaf	Radicle	4.55	3.95 (-47.54)	2.51 (-86.66)	0.20 (-97.34)	0.03 (-99.60)
	Plumule	2.73	3.19 (-29.89)	2.81 (+2.93)	1.93 (-29.30)	1.81 (-33.70)
New shoot	Radicle	4.55	3.97 (-12.75)	3.44 (-24.40)	0.85 (-81.32)	1.09 (-76.04)
	Plumule	2.73	2.77 (+1.47)	2.71 (-0.73)	1.80 (-34.07)	1.37 (-69.89)
Old shoot	Radicle	4.55	5.49 (+20.66)	4.75 (+4.40)	1.79 (-60.66)	1.07 (-76.48)
	Plumule	2.73	2.93 (+7.33)	3.03 (+33.41)	2.82 (+3.33)	2.65 (-2.93)

[1]Treatment extract isolated from leaf and shoot of *T. cordifoli*a

[2]Test crops are the plant seeds on which the extract was tested

[3]Length of radicle and plumule in cm, values in parenthesis indicate percent stimulation (+) or reduction (-) as compared with controls not treated with extract.

DISCUSSION

The bioassay culture, the leaf, new shoot and old shoot of *Tinospora cordifolia* were toxic to all food crops compared with radicle and plumule length of all food crops decreased with increasing concentration of all components of plants (Fig. 1 and 2). The maximum radicle length (3.04 cm) and plumule length (3.86 cm) irrespective of crop and concentration was in old shoot. While minimum radicle (1.65 cm) and plumule (2.62 cm) was in new shoot which was most toxic to the crops.

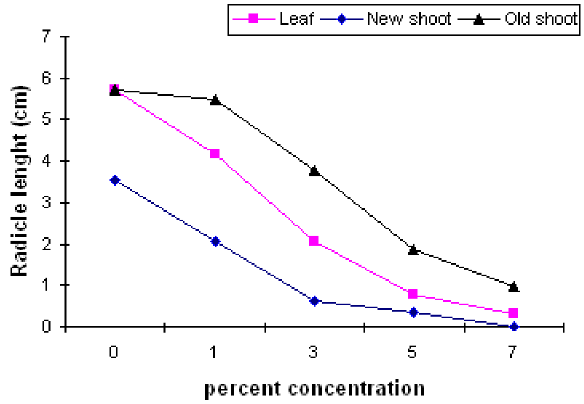

Fig. 1: Effects of percent concentration of different extracts on radicle length (irrespective of food crops)

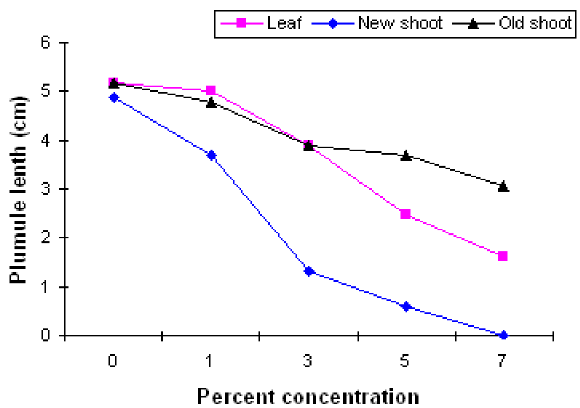

Fig. 2: Effects of percent concentration of different extracts on plumule length (irrespective of food crops)

Similarly when crops were analysed in different concentration irrespective components of *T. cordifolia*, the length of radicle and plumule of *S orientala*, *C. cajan* and *E. coracan* were 1.37 and 2.70, 2.65 and 4.54 and 2.43 and 2.48 respectively.

The germination percent of *S. orientala* (irrespective percent concentration) the maximum reduction (50.51 %) in germination over control was in new shoot of *Tinospora conrdifolia* followed by 35.97% in leaf and 7.65% in old shoot. Similarly the germination of *C. cajan* was reduced highly followed by old shoot, however, the new shoot had reduced slightly its germination percent. The germination of *E. coracan* was affected most by leaf and least by old shoot. The germination when assessed the leaf and old shoot was most and least toxic respectively for all crops.

Agro technologies for cultivation of a number of species have been developed in Himalaya region. The phytotoxic effects of substances released by certain tree of agroforestry on germination and growth attributes of associated crops in Garhwali Himalaya [17,18] and other parts of country [19] have been amply demonstrated.

Allelochemicals are frequently secondary plant products such as phenolics, terpenoids, or organic acids, which are or can be transformed into germination or growth -inhibitory components Putnam and Duke [20]. These allelochemicals affect enzyme responsible for plant hormone synthesis, in addition to inhibition of nutrient and ion absorption by affecting plasma membrane permeability [21]. Effect of a given compound or plant metabolites might be inhibitory or stimulatory depending on their concentration in the surrounding medium [22]. The present study definitely suggests that the addition of aqueous leachates of *Tinospora conrdifolia* strongly affects the germination efficiency and growth characters of all the food crops when compared to the control. In addition an indirect association between lower seed germination and allelopathic inhibition may be the consequence of the inhibition of water uptake [23].

Allelochemical like terpenoids and flavonoides which reduced the growth and development of plant are come in the soil through volatilization and leaching while phytochemical glycosides are come in soil through the leaching with dew, rainwater etc [24]. However, long-term studies are needed to test these allelopathic effects under more natural condition. Since the phytochemical characters of the soil and the microbial activity could mitigate or intensify this effect [25]. The allelopathic potential of *Tinospora cordifolia* root and its relative importance to inhibition of crops growth by leaves also need to be examined.

Thus the present study may help in planning for the development of medicinal plant based agronomic practices. The policies and planning have clearly identified medicinal plants as a potential resource for upliftment of economy of any region. In this context, medicinal plants are viewed as a possible bridge among sustainable economic development, affordable health care, conservation of vital diversity of medicinal flora and traditional gene bank of food crops.

REFERENCES

1. Zhao, Y.J., 2000. The importance and applied prospect of plant allelopathy in medicinal plants cultivation. Chinese Traditional and Herbal Drugs, 31: 1-4.

2. Liu, Y.H., R.S. Zeng and S. Chen, 2007. Plant autotoxicity research in southern China. Allelopathy J., 19: 61-74.
3. Politycka, B., 2005. Soil sickness and Allelopathy. Allelopathy J., 16: 77-84.
4. Anonymous, 1976. Wealth of India: Raw materials, Vol X. New Delhi: CSIR.
5. Nadkarni, K.M. and A.K. Nadkarni, 1976. Indian Materia Medica, Vol 1. 3rd ed. Mumbai: M/S Popular Prakasan Pvt. Ltd.
6. Chopra, R.N., S.L. Nayar, I.C. Chopra, 1956. (eds). Glossary of Indian Medicinal plants. New Delhi: CSIR.
7. Zhao, T.F., X. Wang, A.M. Rimando and C. Che, 1991. Folkloric medicinal plants: *Tinospora sagittata var. cravaniana* and *Mahonia bealei*. Planta Med., 57: 505.
8. Nayampalli, S., S.S. Ainapure and P.M. Nadkarni, 1982. Study of antiallergic acid Bronchodilator effects of *Tinospora cordifolia*. Indian J. Pharm., 14: 64-6.
9. Nayampalli, S.S., S.S. Ainapure, B.D. Samant, R.G. Kudtarkar, N.K. Desai and K.C. Gupta, 1988. A comparative study of diuretic effects of *Tinospora cordifolia* and hydrochloro-thiazide in rats and a preliminary phase I study in human volunteers. J. Postgrad Med., 34: 233-6.
10. Ikram, M., S.G. Khattak and S.N. Gilani, 1987. Antipyretic studies on some indigenous Pakistani medicinal plants: II. J. Ethnopharmacol., 19: 185-92.
11. Nayampalli, S.S., N.K. Desai and S.S.Ainapure, 1986. Anti-allergic properties of *Tinospora cardifolia* in animal models. Indian J. Pharm., 18: 250-2.
12. Pendse, V.K., A.P. Dadhich, P.N. Mathur, M.S. Bal and B.R. Madam, 1977. Anti-inflammatory, immunosuppressive and some related pharmacological actions of the water extract of Neem Giloe (*Tinospora cordifolia*)-A preliminary report. Indian J. Pharm., 9: 221-4.
13. Stanely, M., P. Prince and V.P. Menon, 2001. Antioxidant action of *Tinospora cordifolia* root extract in alloxan diabetic rats. Phytother Res., 15: 213-8.
14. Basotra, Rohan, Shashi Chauhan and N.P. Todaria, 2005. Allelopathic effects of medicinal plants on food crops in Garhwal, Himalaya. J. Sustainable Agriculture, 26: 43-56.
15. Nazir, Tahir, A., K. Uniyal and N.P. Todaria, 2007. Allelopathic behaviour of three medicinal plant species on traditional agriculture crops of Garhwal Himalaya, India. Agroforestry Systems, 67(3): 183-187.
16. Guo, L.P., L.Q. Huang and Y.X. Jiang, 2006. Soil deterioration during cultivation of medicinal plant and ways to prevent it. China J. Chinese Materia, 31: 714-717.
17. Negi, B.S., D.S. Chauhan and N.P. Todaria, 2007. Allelopathic effects of *Ougeinia oojeinensis* Roxb. (Fabaceae) on the germination and growth of wheat, barley and mustard. Allelopathy J., 20: 403-410.
18. Singh, Bhupendra, Jhaldiyal,Vivek and Kumar Munesh, 2009. Effects of aqueous leachates of multipurpose trees on test crops. Estonian J. Ecology, 58(1): 38-46.
19. Kumar Munesh, Lakiang, J.J. and S. Singshi, 2008. Tree cop interactions in the agroforesty systems of Mizoram. J. Tropical Forest Sci., 20(2): 91-98.
20. Putnam, A.R. and W.B. Duke, 1978. Allelopathy in Agroecosystems. Ann. Rev. Phytopathol., 16: 431-451.
21. Fujii Y., M. Furukawa, Y. Hayakawa, K. Sugahara and T. Shibuya, 1991. Survey of Japanies medicinal plants for the detection of allelopathic properties. Weed. Res. Tokyo, 36: 36-42.
22. Khailov, K.M., 1974. Biochemical traphodynamics in marine coastal ecosystems. Kiev, USSR, Naukova Dumka.
23. El-Khatib, A.A., 1997. Does allelopathy involves in the association pattern of *Trifolium resupinatu*. Biol. Plant, 40: 425-431.
24. Tukey, H.B., 1970. The leaching of substances from plants. Annual Review of Plant Physiol., 21: 305-324.
25. Kamara, A.Y., I.O. Akobunda, N. Sanginga and S.C. Jutzi, 1999. Effects of mulch from 14 multipurpose tree species (MPTs) on early growth and nodulation of cowpea (*Vigna unguiculata* L.). J. Agronomy and Crop. Sci. 182: 127-138.